9.0 SNAKE RIVER SOCKEYE SALMON ESU

9.1 BACKGROUND

9.1.1 Description of the ESU

This ESU consists of the remnant population of sockeye salmon that existed in Redfish Lake in the upper Salmon River at the time of listing, fish residing in the captive rearing program, and "residual" sockeye salmon (kokanee-size fish that spawn at approximately the same place and time as the anadromous sockeye salmon).

9.1.2 Status of the ESU

The Snake River Sockeye ESU was listed as endangered on November 20, 1991 (56FR 58619), after declining to an annual abundance of 0 to 29 anadromous adults immediately prior to listing (Table 9.1). More recent annual abundance has ranged from 7 to 257 returning adults between 1999 and 2003 (Table 9.1**)**. The annual abundance of spawning "residual" fish in the ESU is unknown but believed to be fairly small. The overwhelming majority of fish and the genetic heritage of this ESU reside in the captive rearing program.

9.2 ASSESSMENT OF HATCHERY PROGRAMS

9.2.1 Snake River Sockeye Hatchery Programs

9.2.1.1 Broodstock History. In 1990, no adult sockeye salmon were observed returning to the Redfish Lake spawning area, and an emergency artificial propagation program was established in 1991. A fraction of the 1991 emigrant smolts, believed to be progeny of anadromous adults that spawned in 1988 and 1989, were also trapped at the outlet of the lake and placed into the captive-reared broodstock program. These fish, along with 16 anadromous adults that returned to Redfish Lake between 1992 and 1997, founded the captive broodstock that now includes nearly all of the remaining members of this ESU. The founding stock, which has been rearing and mating in captivity, has increased to a captive population of several thousand fish of four or five year classes. This program annually produces up to 200,000 eyed-eggs, which are reared at several hatchery facilities and released into Redfish Lake, Alturas Lake, and Pettit Lake in the upper Salmon River. Various life stages have been outplanted into the lakes, including eyed eggs, fry, pre-smolts, full-term smolts, and adults.

9.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Virtually the entire population of Snake River sockeye salmon was taken into the captive rearing program in the 1990s. At this time, most of the population remains in captive propagation and nearly all of the fish observed in the wild are a result of the captive broodstock program. Nearly all of the genetic diversity in this ESU is thought to reside within the captive rearing program.

9.2.1.3 Program Design. This program was originally designed as a short-term (approximately one to two generations) emergency intervention, designed to give managers time to define and address the primary threats to this ESU. The captive program has continued beyond this original "short-term" period, because the anadromous sockeye salmon has remained at very low abundance. The program is operated under the oversight of the Stanley Basin Sockeye Technical Advisory Committee (SBSTOC), which is a group of senior scientists who are expert in fish culture and genetics. Members represent the State of Idaho, the FWS, NOAA Fisheries, Shoshone-Bannock Tribes, the University of Idaho, and BPA. The SBSTOC annually reviews and recommends specific mating protocols to maximize effective population size and release strategies.

Table 9.1. Adult anadromous sockeye salmon returns to the Redfish Lake Creek weir 1954-1968 (Bjornn et al. 1968) and the Redfish Lake Creek trap and Sawtooth Fish Hatchery weir (1991-2003) (L. Hebdon, IDFG, pers. comm.). No data are available for 1967-1984.

Year	Adults	Year	Adults
1954	998	1979	
1955	4,361	1980	
1956	1,381	1981	
1957	523	1982	
1958	55	1983	
1959	290	1984	
1960	75	1985	11
1961	11	1986	29
1962	39	1987	16
1963	395	1988	1
1964	335	1989	1
1965	17	1990	0
1966	61	1991	4
1967		1992	1
1968		1993	8
1969		1994	1
1970		1995	0
1971		1996	1
1972		1997	0
1973		1998	1
1974		1999	7[1]
1975		2000	257[1]
1976		2001	26[1]
1977		2002	22[1]
1978		2003	14[1]

[1] Progeny of captive broodstock program

9.2.1.4 Program Performance. The captive broodstock program has been successful in temporarily rescuing this ESU from extinction, but it has had limited success in increasing anadromous fish and natural reproduction. The BRT (2003) summarized this program and the SBSTOC overseeing it as producing "groundbreaking research in captive broodstock technology and limnology." The enhanced scientific knowledge and successful preservation in captivity are the primarily accomplishments. The program has demonstrated limited ability to successfully produce anadromous sockeye salmon, except in 2000 when 257 anadromous adults returned. Most originated from a full-term smolt release made in Redfish Lake Creek. Attempts to repeat the smolt release have been unsuccessful due to lack of hatchery facilities or disease outbreaks.

9.2.1.5 VSP Effects

Abundance – The captive broodstock program may have prevented extinction of the ESU. There has been a small increase in anadromous adults since 2000, compare with the number that returned between 1988 and 1999 (see Table 9.1). The captive broodstock program is consistently producing 200,000 eyed-eggs annually, a number far higher than what is currently produced via natural production in the Stanley Basin Lakes.

Productivity – The captive broodstock program has multiplied by many times the number of adults and eyed-eggs that would have occurred naturally. However, natural productively remains very low, as demonstrated by the number of anadromous sockeye salmon returning in recent years.

Diversity – The genetic diversity of this ESU is limited by the very small size of the founding population and the inbreeding inherent with population so small and the length of time it has been kept within the captive broodstock program (more than three generations). At this point, it is a "closed" population with all individuals sharing common ancestors. However, careful mating protocols, including matrix matings, have increased the number of families and prevented loss of any genetic material. Diversity in this program is being protected as much as possible, but it will continue to be subject to inbreeding problems the longer this ESU is forced to rely on the program for its existence.

Spatial Structure – The program has expanded the distribution of sockeye salmon from Redfish Lake to also include Alturis and Pettit lakes via releases from the captive program.

9.3 CONCLUSION

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Endangered

9.3.1 ESU Overview

9.3.1.1 History of Populations. Historically, sockeye salmon were known to occur in several subbasins within the Snake River basin. At the time that Snake River sockeye salmon were listed in 1991, populations in Wallowa Lake (in the Grande Ronde River subbasin), the Payette Lakes

(in the Payette River subbasin) and Warm Lake (in the South Fork Salmon River subbasin) had been extirpated, and Redfish Lake (near the headwaters of the Salmon River) was the only extant population in the ESU (Flagg and Mahnken 1995).

9.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

None. This ESU contains only one population, and that population is primarily contained within a captive propagation program. For approximately three generations, the ESU has depended on the captive propagation program to prevent extinction. The captive broodstock program was founded with a small number of fish that are all thought to be genetically related.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

None.

Mixed (Integrated Programs[c])

The captive broodstock program is integrated. Most anadromous adults have been taken into the captive broodstock program to maintain genetic variability. Most of the naturally spawning fish have been derived from the hatchery program.

Hatchery (Isolated[d])

None.

9.3.2 Summary of ESU Viability

9.3.2.1 Abundance. All risk factors for this ESU are rated as very high, starting with low abundance (BRT 2003). Abundance is summarized above in Table 9.1. The captive program is producing 200,000 embryos annually, but it has produced few anadromous adults. Anadromous

---

[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

adult returns remain less than 30 adults annually, most derived from the captive broodstock program.

9.3.2.2 Productivity. Low productivity was rated as a very high risk factor that limits the likelihood that this ESU will persist or recover without intense artificial intervention (BRT 2003). The captive program is successfully established, but it has annually returned only a few anadromous adults in all but one year. Productively of the natural fish remains very low.

9.3.2.3 Spatial Structure. Spatial structure was also rated a high risk for this population, which persists only in one lake and in the hatchery. Reintroduce of sockeye salmon into Alturas and Pettit Lakes is being attempted using fish from the captive program.

9.3.2.4 Diversity. The genetic diversity of this ESU is limited by the very small size of the founding population, inbreeding inherent with so small a population, and the length of time it has been kept within the captive broodstock program (more than three generations). At this point, the captive program is a "closed" population with all individuals sharing common ancestors. However, careful mating protocols including matrix matings have increased the number of families and prevented loss of genetic material. More diversity may be lost the longer the ESU is forced to rely on this program for its existence.

9.3.3 Artificial Propagation Record

9.3.3.1 Experience with Integrated Programs. The Snake River sockeye captive propagation program has been in operation for 13 years. At the start of this program, captive broodstock technology was in the early development stage. Monitoring and evaluation supporting effective adaptive management are strengths of this program.

9.3.3.2 Are Integrated Programs Self-Sustaining. The captive propagation program is producing enough embryos to support future broodstock requirements, planned research, and release of juveniles back into the lakes. Naturally produced fish continue to be at extremely low numbers.

9.3.3.3 Certainty that Integrated Programs will Continue to Operate. The captive propagation program is funded by Bonneville Power Administration through the Northwest Power and Conservation Council's Fish and Wildlife Program. Long-term funding seems to be certain, but it must compete with other projects for funding in the Fish and Wildlife Program.

9.3.4 Summary of Overall Extinction Risk Faced by the ESU

This ESU continues to be at immediate risk of extinction and continues to depend on the captive broodstock program for its existence. Fish in the captive program appear to be stable, but face increasing risks of inbreeding the longer this program has to be relied upon. There are few naturally produced adults left, and the program has not demonstrated a consistent ability to produce anadromous adults. Future prospects for this ESU remain uncertain.

9.4 LITERATURE CITED

Bjornn, T. C., D. R. Craddock, and D. R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, *Oncorhynchus nerka*. Trans. Am. Fish. Soc. 97(4):360–373.

BRT (Biological Review Team) 2003. Preliminary Conclusions on the Updated Status of Listed ESUs of West Coast Salmon and Steelhead. Review Draft report Northwest Fishery Science Center, Seattle, Washington February 2003.

Flagg, T.A., and C.V.W. Mahnken. 1995. An assessment of the status of captive broodstock technology for Pacific salmon. Report to Bonneville Power Administration, Contract DE-AI79-93-BP55064, Project 93-56, Portland, Oregon.